

# ***Managing Schedule & Financial Risk In a Faster, Better, Cheaper Development***

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## *Track 2: Space Missions, Systems and Architecture*

### **2.08 Managing Risk for Faster, Better, Cheaper Missions and System**

#### **Abstract:**

The X2000 Program is a technology development program that will provide next generation Avionics for missions to deep space. The goal of the X2000 Program is to develop revolutionary flight and ground systems which can be replicated by missions at a low cost, affording timely new science and mission opportunities to investigators and institutions.

The X2000 IFDP is to provide multi-mission prototypes and engineering models for deep space missions to be launched in circa 2004.

When Daniel S. Golden became the Administrator for the National Aeronautics and Space Administration (NASA), he announced that the new policy for the agency was going to be a Faster, Better, Cheaper approach to space exploration. People were not sure what that meant but after about four years it became evident that it

meant shorter development times, cost capped missions, and new technology for those missions. With the implementation of shorter development phases for project's, the need for better metrics to track a project's status became necessary. Several Risk Reduction methodologies have been employed to track technical, schedule, and financial risk. This paper will describe different methods for tracking such performance. Schedule performance will be discussed using Event-Driven Performance Assessment Metrics, Receivables/Deliverables, Slack tables, etc. Financial performance will be addressed by discussion of Earned Value (Cost variance/Schedule variance), Cash flow, Reserves management, Risk reduction funds, etc. Although X2000 IFDP is not a flight project it is delivering hardware to other project's and is being managed as if it were a flight project. It is currently utilizing many of the methods described in this paper.

#### **1.0 Introduction**

The X2000 Integrated First Delivery Project (IFDP) is a technology and system development program that services missions to deep space. The goal of the X2000 IFDP Program is to develop revolutionary flight and ground systems which can be replicated by missions at a low cost, affording timely new science and mission opportunities to investigators and institutions. The X2000 IFDP is to provide multi-mission prototypes and engineering models of technologies and systems, including flight software for deep space missions to be launched in circa 2005.

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announced that the new policy for the agency was going to be a Faster, Better, Cheaper approach to space exploration. People were not sure what that meant but after about four or five years it became evident that it meant shorter development times, cost capped missions, and new technology for those missions. With the implementation of shorter development phases for project's, the need for better metrics to track a project's status became necessary. Several Risk Reduction methodologies have been employed to track technical, schedule, and financial risk. This paper will focus on schedule and financial risk and some of the metrics that are employed in the dynamic project environment.

Risk identification is the process of determining which risks are likely to affect the project and understanding the cause of those risks. Risk identification is not a one-time event; it should be performed on a regular basis throughout the project life cycle. Risk identification should

address both internal and external risks. Internal risks are things that the project team can control or influence, such as staff assignments and cost estimates. External risks are things beyond the control or influences of the project team, such as funding cuts or launch delays.

## 2.0 Schedule Metric

### *Web based Product Receivables/Deliverables*

More commonly referred to as Rec/Del's this system is a web based cross-organizational tool that is part of the JPL Customer-oriented Management Information System (CMIS) which was developed for the Cassini project. It acts as an electronic handshake or agreement between the receiver and deliverer of a product. The system is organized around the project Work Breakdown Structure (WBS). The main strength of the tool

is that it allows distributed planning with immediate responsibility and accountability. Product receivables and deliverables can be defined, scheduled, negotiated, and reconciled across WBS elements, between managers, and even inter-project if both are using the system. The system is easy to use, is low cost and provides Email notification of upcoming events. See Figure 1 for an example of a Rec/Del.

**Enterprise - ID: 3343 - Netscape**

File Edit View Go Communicator Help

Back Forward Reload Home Search Netscape Print Security Shop Stop

Bookmarks Location: |nasa.gov:2000/cgi-bin/RD.exe/Enterprise/RecDel/getDetail?RDID=3343 What's Related

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**RecDel Detail**

Submit Changes Delete Printable Version

Dates OK

**ID - Title** **Value**  
 3343 - Fault Protection Description Doc - Final

Due Date	Received Date	Not Received	Baseline Date	Slip Count
5/21/2001			9/15/2001	0

Deliverer		Receiver	
7.2.F.1.T - Flight System Engineering ( A )		7.2.1.1.T - Project Office Staff ( A )	
Cecilia N Guir	4-3632	David F Woerner	3-2000

Delivery Date	Deliverer Agrees?	Required Date	Receiver Agrees?
5/21/2001	Accept	5/21/2001	Accept

**Deliverer's Notes**  
None

**Receiver's Notes**

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Figure 1. X2000 IFDP Rec/Del

### Detailed and Intermediate Schedules

Microsoft Project is the selected software for the X2000 IFDP project. This tool is desirable for a number of reasons. The first of which is that it is multi-platform and can be used on a PC and a Mac with equal ease. The second reason is that it provides both detailed and intermediate schedule information and roll up. Linking information from the detailed schedules can create intermediate schedules that are derived from detailed networks. The information in the intermediate file is then updated when the detailed schedule is updated. All of the schedule information is kept on a common server that is accessible to all the Cognizant Engineers (Cog E's) and Program Element Managers (PEM's). Another element that is of great importance is the Critical Path of a project schedule. Most tasks in a project have some "slack" and can be delayed a little without affecting the finish date. Those tasks that cannot be delayed without affecting the finish date are said to be on the "Critical path." Microsoft

Project allows you to filter tasks so the critical path can be adjusted without affecting the finish date, and allows slack to be measured.

### Cumulative Receivables/Deliverables

The cumulative Receivables/Deliverables chart is a tracking mechanism that is derived from the Rec/Del System. This metric tracks the key receivables and deliverables for the project. It tracks schedule slips as well as open and pending requests for agreements that need to be renegotiated. Figure 2 depicts a typical twelve- (12) week report. This chart tells the viewer, in a graphical sense, how they have done against the original baseline, the current baseline, and actual performance tracked against each. This particular snapshot shows that the current plan is very different from the baseline. The project has not re baselined but is clearly operating to a different schedule. There is an additional cut of

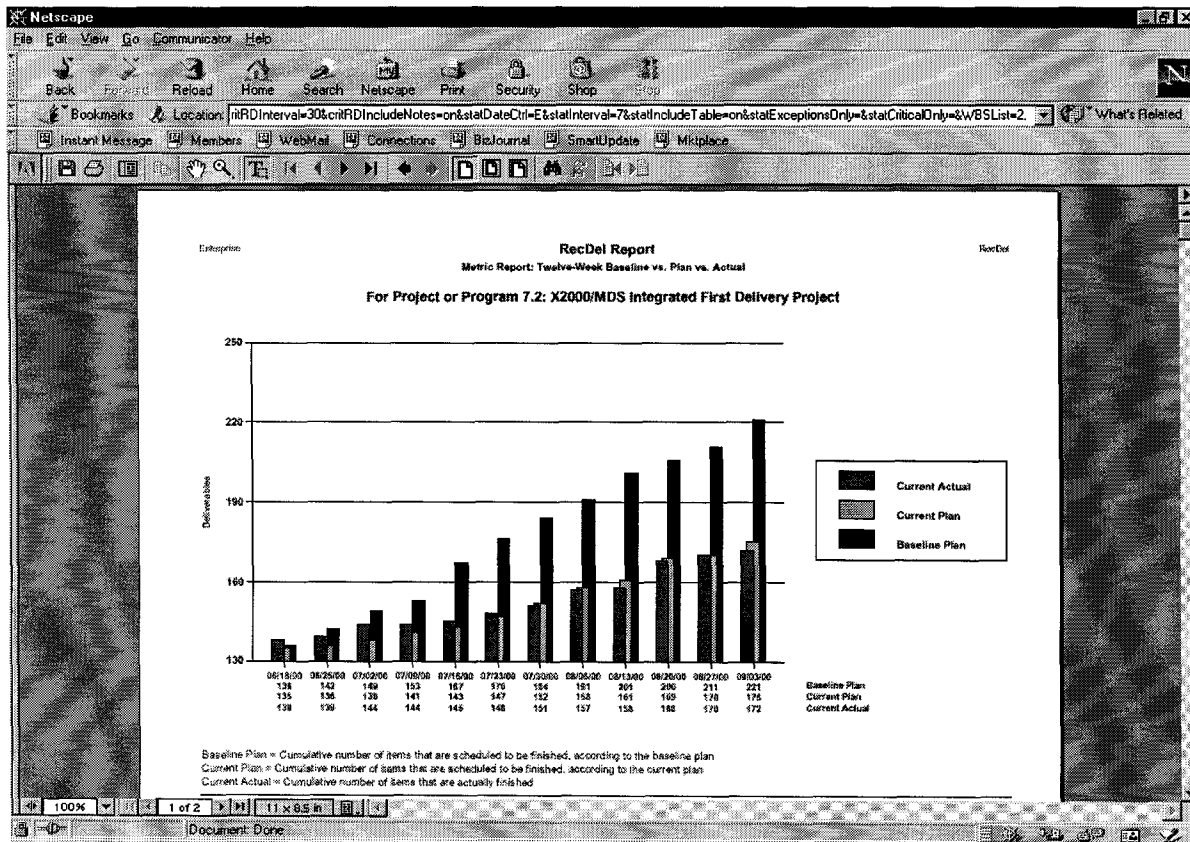


Figure 2. Rec/Del Metric

this chart that shows performance on a monthly basis for the past six months and six months plan in the future.

*Event Driven Performance Assessment Metric (PAM)*

medium event is one that is greater than three days but less than one month. This type of event is given a start and end date that matched the schedule. A longer event could be an integration activity that is longer than a month and can be given intermediate milestones along the way. For tasks of more than one month, events are assigned for each month during the task. This method avoids a one-month task being assigned the same weight as a six-month task. The events are then graphed cumulatively over the time-span of the project, and indicate a planned, late-finish, and actual completion of the events. The actual line should fall between the other two, and

The PAM is created from the detailed schedules. Depending on the length of the task in the network, the PAM assigns a number of events to the task. Events can be defined as milestones on a detail level schedule. Events come in three types and are defined in the following way. A short event is one that is less than three days, a critical review for example. A if the actual line falls at or below the late-finish, the metric indicates that schedule reserve is lost and critical-paths are likely affected. Figure 3 shows a Performance Assessment Metric for the X2000 IFDP project.

Each month, the number of actual events is compared against the plan to yield a schedule only driven Schedule Performance Index (SPI). The ratio is expressed as actual events divided by Planned events. In this metric the SPI would be as 93%. If the project were using Earned Value Measurement, this SPI should compare favorably with the one that comes out of Earned Value.

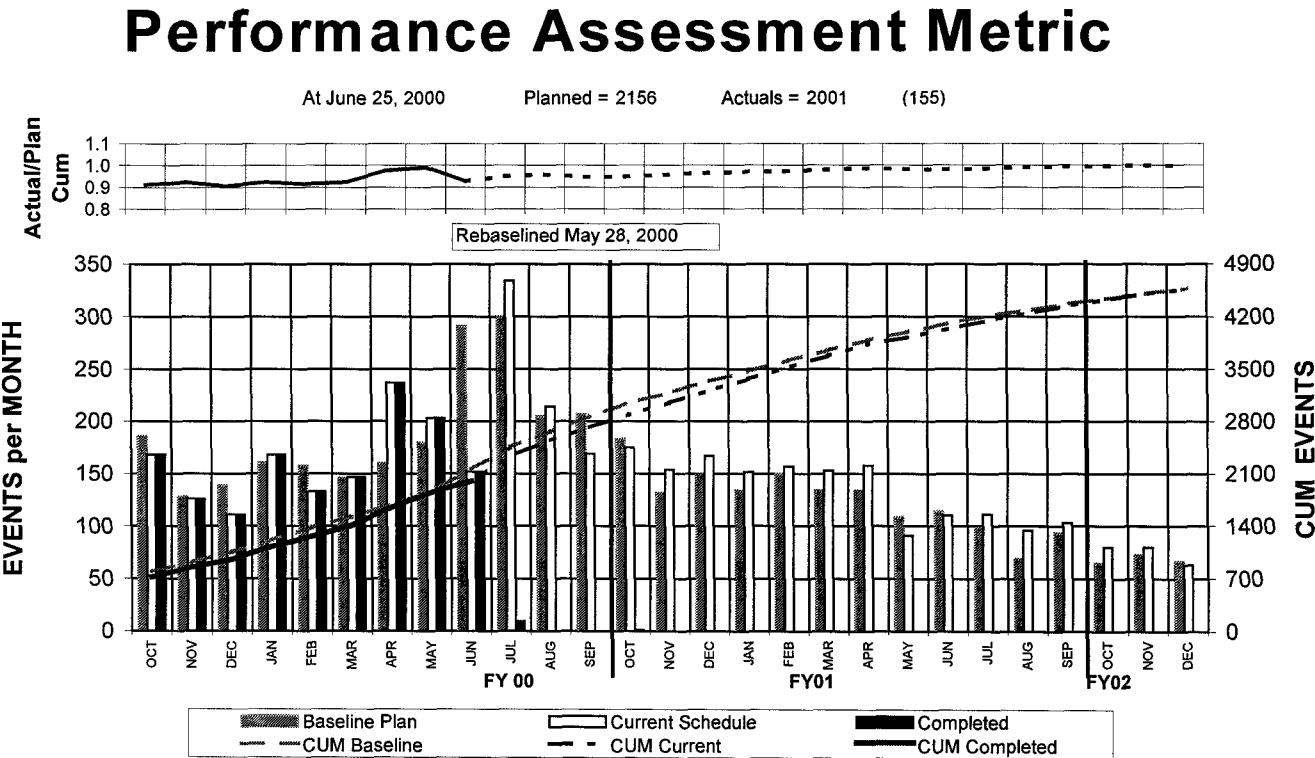


Figure 3. Performance Assessment Metric

### Integration and Test Critical Path

Figure 4 is an example of information that can be taken from the project's detailed and intermediate schedules as well as the Rec/Del system. What this chart attempts to show is how little or much slack a deliverable to Integration and Test carries and how it stands with respect to deliveries of different sub assemblies and products to Integration and Test. As shown below, it highlights certain areas of interest. It lists the product that is to be delivered and what the deliverer's current plan reflects. In addition it shows the date that Integration and Test require the product. Slack is that amount of time that the product can slip with out affecting the critical path or the next assembly. Internal too

most all of the schedules are a built in reserve. The final column shows the manager what their total position is. Slack + reserve is the total time that the item can slip without affecting the next product in line.

A project manager can use all of these tools to perform an overall schedule risk assessment and identify critical areas that need to be worked in a proactive manner. If the Rec/Del's are not being negotiated and reconciled by the individual PEM's that alone can indicate problem areas. It is important to understand that all of the tools should be used in concert to get a clear and overall picture of what is going on.

### Deliveries to I&T that are closest to Critical

LEGEND	Under six weeks = 5.1
	Under four weeks = 3.1
Data as of - Sept 12,	Under one week = 0.6

Build Up	Product	Deliverer's Current Plan	Required by	Slack (Weeks)	Slack + Reserve	
PT-MDS	PSS (1	12/1/0	11/2/0	<b>-4.1</b>	<b>0.0</b>	Delivery 5/11/01
PT-MDS	PSS (3	12/1/0	11/23/0	<b>-1.1</b>	<b>2.9</b>	
EM-MDS	SFC	11/15/0	1/12/0	8.3	12.3	
EM-MDS	SFC	12/22/0	9/10/0	37.4	41.4	
EM-MDS	SIO	5/14/0	7/17/0	9.1	13.1	
EM-MDS	SIO	5/28/0	7/17/0	7.1	11.1	Delivery 12/1/00
EM-	SIO	4/16/0	5/28/0	6.0	10.	Delivery 3/4/02
EM-FDP	SIA EM	11/1/0	11/1/0	<b>0.0</b>	4.0	
EM-FDP	SIA EM	11/2/0	1/14/0	10.4	14.4	Delivery 4/8/02

Figure 4. Deliveries to Integration and Test – Critical Path Path

### 3.0 Financial Metrics

In today's environment, a project manager is being held responsible for not just technical and schedule goals, but they must also meet the financial goals of the program. The management of a project from a financial standpoint requires detailed planning of all accounts and then managing to those budgets. The term "scope, schedule, and budget" means just that. Understand the scope of the task or project, construct a schedule that will deliver the product on time and finally design and put in place a budget that will support scope and schedule.

#### Budget versus Actual Expenditures

One of the most important aspects to managing to cost is the construction and reporting of actual expenditures versus the budget. Figure 5 shows how this can be accomplished with some tools that are usually available from the institution and are accepted as a reporting standard. These tools are only as valuable as the basis of estimates for the budgets and the project's ability to control expenditures. Almost as important as controlling expenditures is the baseline plan. The project should establish a baseline budget at the beginning of the year and unless there is a "major" change in scope or direction that baseline should not be changed.

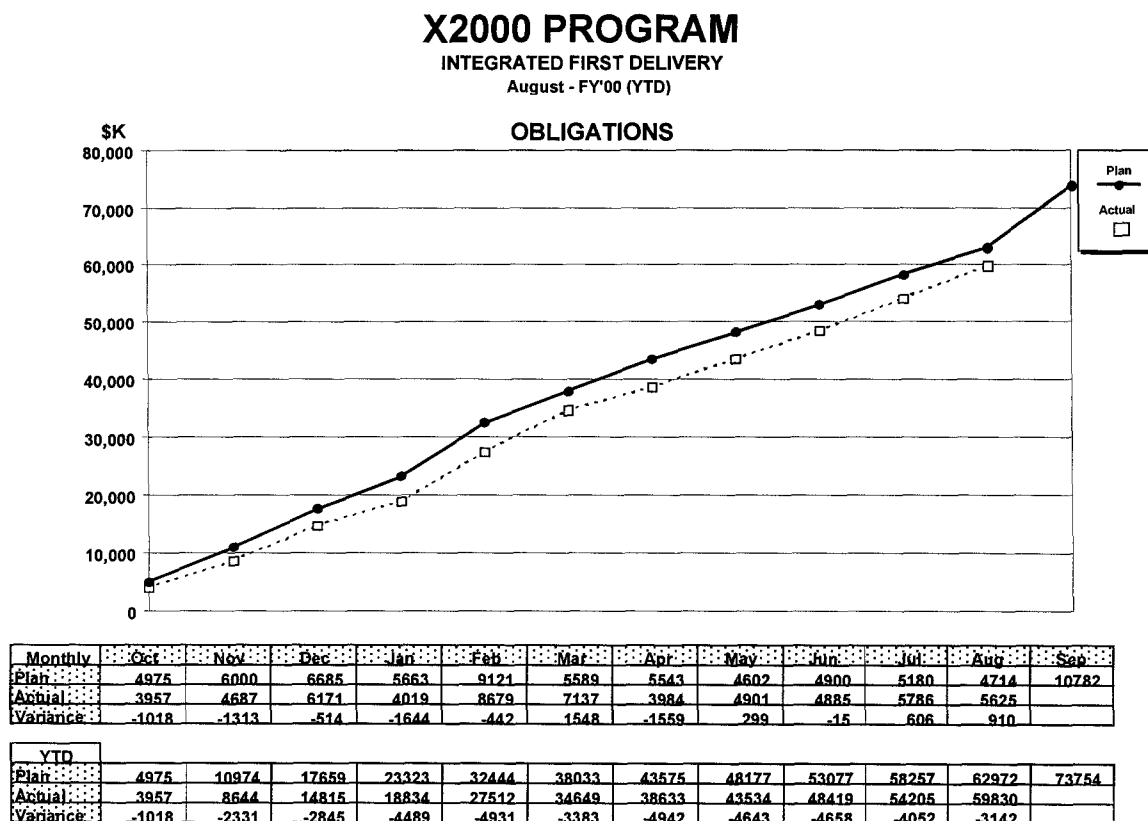


Figure 5. X2000 IFDP Plan versus Actual

### Managing Funds and Cashflow

Along with establishing a solid base-line budget one of the next most difficult things for a project manager to do is manage their funding and the cash flow associated with the funding. If the project is part of a larger activity and is not funded, as a single entity then its funding could be at risk if another part of that activity gets into trouble. If activities are to be funded in addition to the baseline funding then they must be called out and specifically identified less they could be lost in the larger picture. Having a good funding profile and an expenditure plan to go along with it is allocation of funds, as well as any additional increments that may have been allotted to the project. It also shows what the plan is against those funds and what the project's reserve position and percentage is by year. A report like this should be part of every monthly, it is very important. Being sure that procurements are funded in a timely manner and proper amounts is critical. If funds are allocated to a vendor ahead of schedule then a short fall at the project level could arise leaving the project with insufficient

resources to fund needed services for other areas. Figure 6 is an example of how this information can be communicated. This shows the initial quarterly, and yearly review so everyone concerned is kept aware of the funding and expenditure status of the project.

### Managing Reserves

Crucial to a project's success is determining the proper reserves profile. This task is complicated because it varies from project to project depending on the complexity of the task. If the project manager feels that the project has the proper scope, schedule, and budget then a reserve profile that fits the requirement for funds can be established. Reserve levels can be determined in many ways. One way is to apply a percentage at the bottom line. An example would be to add 25% to any or all year's costs as an estimate for reserve. Another way is to apply a percentage to the areas where it is thought that most of the rise lies. This percentage should be

### X2000 INTEGRATED FIRST DELIVERY PROJECT ALLOCATION & RESERVES PROPOSED

STATUS AS OF September 25, 2000 (OBLIGATIONS)

	FY'98	FY'99	FY'00	FY'01	FY'02	FY'03
TOTAL ALLOCATION	16,665	36,414	40,000	50,000	3,000	
Less FY '00 Funding Shortfall			3,500	2,500		
POP 2000-1 Over Guideline Funds				3,000	7,000	6,500
CARRY FORWARD '98/'99/00	-452	1,240	726	1,282		
ADJUSTED ALLOCATION	16,213	37,654	44,226	56,782	10,000	6,500
PLANS (Obligation Actuals in 1998,1999 & 2000)	16,213	37,129	40,000	55,000	8,000	7,025
RESERVES	0	0	4,226	1,782	2,000	0
As a % of Total Allocation			9.56% #	3.14% #	20.00% #	0.00%

Figure 6. Source and Use of Funds

based on the perceived risk in that area. Under normal circumstances, reserves are to be used to take care of problems that arise in the normal course of a project's life cycle. They can be for design improvements, contract over runs, scope changes, and any number of other things. Figure 7 shows what a typical "lien" list may look like for a project. A lien is a request from the manufacturing or design side of the operation for additional funds to solve a problem. The problem can be a design issue, schedule related, or risk reduction. Liens come in two forms, hard

and soft. A hard lien is one that must be incorporated into the baseline because of a scope change or some other circumstance that makes it necessary. A soft lien is a request for additional funds to do something that is not required but would add value or reduce risk if incorporated. Soft liens can also be considered as a projection of possible risk or problem areas that might lie ahead as perceived by the managers. Liens can add or deduct cost; a contract modification to reduce scope is an example of a negative lien.

Lien Item	FY00 Total	FY01 Total	FY02 Total	Total
<b>HARD LIENS (Approved, Not Incorporated)</b>				
PT-MDS Upgrade for Multi-node capability (MDS Portion) 2FW3	-60	-60	0	-120
PT-MDS Upgrade for Multi-node capability (Avionics Portion) 2FAC2B, M, D, 2FAK5	134	0	0	134
PT-MDS Upgrade for Multi-Node capability (I&T Portion)	78.2	0	0	78.2
Development Environment Support (MDS) 2FW1	160	168	0	328
PWMA and SRCA ASIC Fab acceleration 2FAP3	55	0	0	55
ECR 15613A - Update to ERD (I&T) 2T3	0	11	-30	-19
ECR 15613A - Update to ERD (SFC) - missing	75	75	0	150
GSE Lithium Battery Fail Safes - missing	0	0	0	0
Additional MCS Contract Give-back - missing	-594.8	0	0	-594.8
SEAKR Contract Increase 2FAC3	300	450	0	750
Boeing Mixed Signal ASIC Design Problems 2FAP3	500	0	0	500
I&T Multi-mission test bed facilities	110	0	0	110
<b>Totals</b>	<b>757.4</b>	<b>644</b>	<b>-30</b>	<b>1371.4</b>
<b>SOFT LIENS (Not Approved, Not Incorporated)</b>				
GSE UART/Discrete I/O Capability - missing	300	0	0	300
Systems Engin. 4th qtr workforce	87	0	0	87
Systems Engin.workforce - missing	0	0	400	400
Packaging workforce 2FAK5 & 6	0	0	88	88
MDS Build 7 Workforce (in addition to incorp'd \$890K liens in '02) missing	0	200	600	800
SFC to Firm Fixed Price Contract 2FAC1	1000	1000	0	2000

Figure 7. Hard and Soft Lien List



## Reserves Usage Metric

After the reserves profile by year for the project has been established, it is very important to accurately track usage of those reserves. Keeping track of the hard and soft liens and being able to determine how they affect the total project is paramount. This project established a floor of 10% of cost to go by fiscal year as a level at which reserve usage becomes critical. Any sustained move toward the 10% floor will result in heightened focus on reserve maintenance. If the reserve falls below 10% at any time during the fiscal year, this would indicate the need for a significant de-scope effort be undertaken or a re-plan for the job be considered. Figure 8 presents the Reserves Usage Chart that shows a graph against the 10% reserve floor. As you can see, this chart by its nature is somewhat erratic in its appearance.

This is because as the year progresses and the amount of "costs to go" go down over time then the percentage of that years reserve will increase if liens are not incorporated into the baseline. One of the major benefits to understanding the reserve status as accurately as possible is the ability to release funds for something called "Risk Reduction Liens". A risk reduction lien is one that, if implemented, will reduce either technical or schedule risk on the project. An example of a risk reduction lien would be purchasing additional test equipment, additional labor for schedule relief, or any other item that would buy you time or allow parallel operations that are usually required during testing.

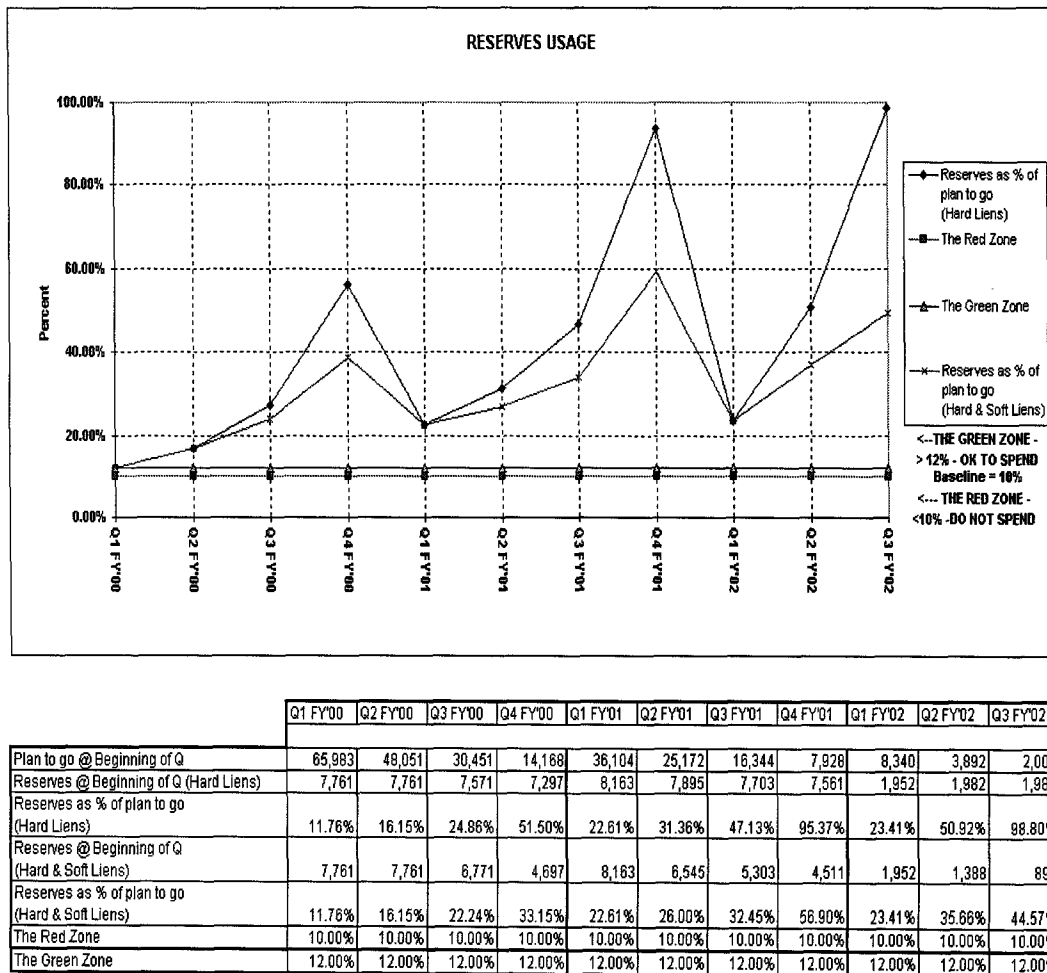


Figure 8. Reserves Usage Chart

## *Earned Value Management*

Although this project does not use Earned Value Management (EVM) it cannot be stated in strong enough terms what the value is to a project with a short development time. Earned value management is a methodology for determining cost and schedule performance of a project by comparing "planned" work with "accomplished" work. Work is planned, budgeted and scheduled in time-phased increments utilizing a Work Breakdown Structure to define tasks and to assign cost to those tasks. As work is accomplished, value is earned on the same basis it was planned. It is not necessary to use a full up earned value system, as

this could be cost prohibitive. An earned value plan (schedule and budget) can be put together in a variety of ways. Scheduling tools can be used with the proper assignment of value to completed tasks. In addition, there are many "off the shelf" tools that can be used if this type of analysis is desired. Its true value is from the schedule variance information that is derived from a properly set up system. A project can be performing within acceptable margins from a cost variance standpoint but could be falling behind schedule. Earned value as a tool for Management to use as part of its over schedule and budget health is of great value.

## 4.0 Summary and Conclusions

During a project's life cycle it will encounter many kinds of "Risk". Typically they are classified as technical, schedule, and financial. This paper has dealt with the last two – schedule and financial. One of the key things that project's can do to reduce the likelihood of surprises is to manage its information and have the ability to react quickly and decisively. This is made possible by installing, monitoring, and reacting appropriately when the management metrics have been put in place to do the job. If you take only one of the metrics mentioned in this paper and use it by it's self it has value but not to the extent necessary. It is only when you

use the schedule metrics, product delivery metrics, cost performance metrics, and reserve forecast metrics, and address "risk" on a comprehensive basis that the value of the tools will come through. Knowing what the "reserves" profile is, with respect to the overall project, will allow management to allocate funds to risk reduction activities such as schedule incentives to vendors or additional workforce. Timely and accurate information and the ability to manage it in a controlled fashion is the key "Metric" for success.

## References

- [1] Bredt D. Martin, Kenneth L. Atkins, Joseph M. Velinga, Rick A. Price, "STARDUST: Implementing a New Manage-To-Budget Paradigm," 1998 IEEE Aerospace Conference, March 1998.

## ACKNOWLEDGEMENTS

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